

PATENT ABSTRACTS OF JAPAN

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(21)Application number : 10-143352 (71)Applicant : KYOCERA CORP

(22)Date of filing : 25.05.1998 (72)Inventor : MATSUDA OSAMU

(54) SUBSTRATE FOR THIN-FILM MAGNETIC HEAD AND THIN-FILM
MAGNETIC HEAD USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To improve heat radiating property of a thin-film magnetic head element and to prevent the contact of the element to a medium by successively depositing a diamond-like carbon film and amorphous alumina film to a specified thickness on a substrate.

SOLUTION: A diamond-like carbon film having 0.7 to 3.5 μm thickness and an amorphous alumina film having $\leq 1.3 \mu\text{m}$ thickness are deposited successively on a substrate. First, a diamond-like carbon(DLC) film 7 is formed through normal temperature plasma CVD method on a disk substrate 6 having an orientation flat face. Then an amorphous alumina film 8 is formed through RF sputtering or ECR sputtering. The amorphous alumina film 8 formed by RF sputtering or ECR sputtering has high film packing rate. Thereby, thermal conductivity is improved

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by the DLC film 7, and as a result, heat can be fast transferred to a slider having high conductivity and the heat radiating property is enhanced.

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CLAIMS

[Claim(s)]

[Claim 1] The substrate for the thin film magnetic heads which comes to carry out the laminating of the diamond-like carbon film with a thickness of 0.7-3.5 micrometers and the amorphous alumina film with a thickness of 1.3 micrometers or less one by one on a substrate.

[Claim 2] The thin film magnetic head which comes to form a magnetic film on the amorphous alumina film of the substrate for the thin film magnetic heads of claim 1.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the substrate for the thin film magnetic heads used for the thin film magnetic head and it which are used for the hard disk drive which is the recording apparatus of a computer, a tape drive,

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etc.

[0002]

[Description of the Prior Art] Conventionally, on the ceramic substrate which turns into a substrate for the thin film magnetic heads from an alumina (aluminum $2O_3$) and the composite of a titanium carbide (TiC) as a principal component, the insulator layer which consists of an amorphous alumina is formed by the sputtering method, and what carried out mirror plane processing of the field with the one side polish machine is used.

[0003] In order that the above-mentioned insulator layer may acquire insulation with the ceramic substrate which is electric conduction material, it forms in order to attain smooth nature further, but especially about the field coarseness of an insulator layer, in order to acquire a field important in order to form a component on it and smoother, it is processed by CMP (CHEMICAL MECHANICAL POLISHING) etc.

[0004]

[Problem(s) to be Solved by the Invention] In order to raise recording density in recent years, it is shown that MR (MAGNETORESISTIVE) which used the magneto-resistive effect for the component of the thin film magnetic head, or GMR (Giant MR) uses, but in the case of such MR component and a GMR component, in order to raise reading sensibility, it is necessary to raise a sense current value.

[0005] Moreover, in the MR head for hard disk drives, or a GMR head, with about 1 microinch, the flying height of a head is small and is becoming close to a NIAKON baton. Therefore, the so-called thermal asperity phenomenon which the magnetic head and media tend to carry out [the phenomenon] contact sliding, and a temperature change produces in MR component section of the thin film magnetic head with the frictional heat at this time, consequently reading sensibility reduces serves as a very big trouble.

[0006] Although it is necessary to raise the heat dissipation nature of the circumference of a component in order to cancel this trouble Therefore, make

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thickness of the amorphous alumina film thin and MR component is brought close to the high aluminum₂O₃-TiC substrate of heat conduction. Heat dissipation nature is raised by this, or the recess by the hardness difference of an aluminum₂O₃-TiC substrate and the amorphous alumina film is used, and the cure of preventing that MR component collides with a media side is performed.

[0007] However, when the thickness of the amorphous alumina film was set to 3 micrometers or less, it was inadequate in respect of withstand voltage.

[0008] Therefore, this invention person is making the diamond-like carbon film in which the both sides of thermal conductivity and a withstand voltage property were excellent compared with the amorphous alumina film cover, as a result of repeating research wholeheartedly in view of the above-mentioned situation, and it found out that this trouble was canceled.

[0009] This invention is completed based on the above-mentioned knowledge, while the object raises the heat dissipation nature of the thin film magnetic-head component section, the contact to the media side of a component is prevented, and it is in offering the substrate for the thin film magnetic heads which was further excellent in film adhesion reinforcement, electric pressure-proofing, and field grace.

[0010] Other objects of this invention are to offer the thin film magnetic head of the high quality which used the substrate for the thin film magnetic heads of this invention, and high-reliability.

[0011]

[Means for Solving the Problem] The substrate for the thin film magnetic heads of this invention is characterized by carrying out the laminating of the diamond-like carbon film with a thickness of 0.7-3.5 micrometers and the amorphous alumina film with a thickness of 1.3 micrometers or less one by one on a substrate.

[0012] It is characterized by the thin film magnetic head of this invention coming to form a magnetic film on the amorphous alumina film of the substrate for the thin film magnetic heads of this invention.

[0013]

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[Embodiment of the Invention] Hereafter, drawing 1 - drawing 4 explain the operation gestalt of this invention. The perspective view in which (a) of drawing 1 and (b) show the substrate 1 for the thin film magnetic heads of this invention, the important section expanded sectional view by cutting plane line X-X [in / in drawing 2 / drawing 1 R> 1 (a)], and drawing 3 are the important section expanded sectional views showing the layer system in which the magnetic film was formed on the substrate 1 for the thin film magnetic heads of this invention. Moreover, drawing 4 is the sectional view showing the busy condition of the thin film magnetic head 2 of this invention.

[0014] As for the slider with which 3 consists of the aluminum₂ O₃-TiC system ceramics, a ferrite, sapphire, etc., and 4, in the thin film magnetic head 2 of drawing 4 , MR component and 5 are media.

[0015] The above-mentioned thin film magnetic head 2 is obtained according to the following production process. First, according to the substrate 1 for the thin film magnetic heads of drawing 1 , as shown in the disc-like substrate 6 with a diameter of 2-8 inches which has an orientation flat as shown in (a), or (b), it is the 3-6 inches one-side corner guard-like substrate 6. On these substrates 6, as shown in drawing 2 , the diamond-like carbon (DLC) film 7 is formed by the ordinary temperature plasma-CVD method, and subsequently the amorphous alumina film 8 is formed by RF spatter or the ECR spatter. Incidentally about the describing [above] ordinary temperature plasma-CVD method, hydrocarbon gas is decomposed in the discharge plasma in a high vacuum, the ion in the plasma and an excited molecule are electrically accelerated to a substrate, and it forms by making it collide that it is also with such high energy.

[0016] For most above-mentioned DLC film 7, it sets in the joint form of four carbon atoms, and a diamond is SP³. He is SP³ to being an orbit. An orbit and SP² Including orbital [both], it excels in surface smooth nature, and a degree of hardness is still higher and it excels in abrasion resistance.

[0017] moreover, the DLC film 7 has high thermal conductivity compared with the amorphous alumina film 8, and is further excellent also in electric insulation -- on

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the other hand, a front face -- it is inferior to description and easy to produce a film defect. further -- the DLC film 7 -- high [3000 or more HV] -- since a degree of hardness, surface polish is difficult and surface smoothing is difficult.

[0018] Then, in order to make the fault of the DLC film 7 complement, while forming the amorphous alumina film 8 on it and making a front face smooth by this, generating of a defect is prevented and good and high withstand voltage is made to provide.

[0019] By having formed the amorphous alumina film 8, the surface 8a becomes a very smooth field, and a magnetic film 9 is formed on surface 8a so that it may be shown subsequently to drawing 3 . pass a slicing process, an ABS side polish process, and ion milling processing (RIE processing) one by one after such a wafer process -- much thin film magnetic heads 2 are obtained simultaneously. About MR component, it is the component used by reading and forms with the ultra-fine processing technology by photograph RISOGURAFU.

[0020] the case where the above-mentioned substrate 6 is produced with the aluminum₂ O₃-TiC system ceramics -- 60 - 80% of aluminum 2O₃ the raw material which uses 40 - 20% of TiC as a principal component -- using -- the inside of atmospheric air or reducing atmosphere -- 1600-1800 degrees C -- a hotpress -- or HIP processing is carried out and it is obtained. This aluminum₂ O₃-TiC system ceramics serves as a very precise sintered compact, and can smooth a front face. In addition, although the aluminum₂ O₃-TiC system ceramics is electric conduction material, it gives insulation by forming the DLC film 7 and the amorphous alumina film 8 on a substrate 6.

[0021] Moreover, after forming the amorphous alumina film 8, it is easy to carry out CMP processing that a film front face should be made still smoother.

[0022] By this, if a front face is expressed with the surface roughness (Ra) measured by AFM (ATOMIC FORCE MICROSCOPY), it will be made to 10Å or less.

[0023] And it is good to set suitably 1.3 micrometers or less of thickness after this polish to 1 micrometer or less, and desirable at the point which will become if the

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effectiveness which radiates heat on the DLC film 7 through the amorphous alumina film 8 by this becomes high.

[0024] Moreover, it is good to set suitably 0.7-3.5 micrometers of thickness of the DLC film 7 to 1-3 micrometers, and, in the case of less than 0.7 micrometers, withstand voltage falls, and if 3.5 micrometers is exceeded, it will exfoliate between the amorphous alumina film 8.

[0025] By the DLC film 7 formed by the ordinary temperature plasma-CVD method in this way, although many defects had occurred on the inside of the film, and a film front face, in the amorphous alumina film 8 further formed by RF spatter or the ECR spatter, the high membrane formation filling factor was obtained, this raised thermal conductivity as the DLC film 7 is also, consequently the twist could burn heat, it could tell and heat dissipation nature was raised to the thermally conductive high slider 3.

[0026] Moreover, the DLC film 7 also raised the withstand voltage property (the ordinary temperature resistance in applied-voltage 10V to the laminating of the DLC film 7 and the amorphous alumina film 8 is set to 1011ohms or more), it is that the surface smooth nature which was excellent in the amorphous alumina film 8 being was obtained, and the substrate 1 for the thin film magnetic heads excellent in field grace was offered.

[0027]

[Example] Hereafter, the example of this invention is explained. The alumina (the mean diameter of 99.9% of purity and raw-material powder: 0.4 micrometers) and the titanium carbide (the mean diameter of 99.5% of purity and raw-material powder: 0.3 micrometers) were used as a start raw material, weighing capacity was carried out so that an alumina might serve as and a titanium carbide might serve as 30% of the weight of a ratio 70% of the weight, about 10% of the weight of titanium oxide TiO_2 was further added to the titanium carbide, and it mixed with alumina balls. Subsequently, mixed powder is fabricated and they are 1600 degrees C and 250kg/cm². Hotpress baking was carried out by the pressure for 1 hour.

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[0028] Thus, after carrying out the grinding process of the produced sintered compact to the shape of a predetermined disk type by the diamond wheel, surface wrapping processing was performed using the diamond abrasive grain. Subsequently, using diamond powder with a mean particle diameter of 0.5 micrometers, a substrate front face, a polish plate, or abrasive cloth was slid relatively, precision polish was performed, and surface roughness Ra of a substrate was made into 18A by this. In this example, the tin surface plate was used as the above-mentioned polish plate.

[0029] From originating in the membrane formation stress accompanying the following membrane formation process next, and the substrate itself deforming, shot-blasting processing is beforehand performed for a membrane formation rear face, and the flatness on the front face of a substrate is deformed into the concave surface.

[0030] And membrane formation formation of the DLC film was carried out in 1-5 micrometers using methane and hydrogen gas by RF plasma-CVD method (RF power: 500W, DC-bias:-250V) as shown in a table 1. The surface roughness Ra of such film is 28-140A.

[0031] Furthermore, the alumina target of 99.5% of purity is used. In a spatter After it forms the amorphous alumina film by the thickness of 3 micrometers and the polish liquid which made spherical alumina impalpable powder suspend in pure water performs mirror plane processing after that, The polish liquid which made spherical Seria impalpable powder suspend in pure water performed the last precision processing, and the laminating of the DLC film into which thickness was changed, and thickness (0.5 micrometers, 1 micrometer, and 1.5 micrometers) of the amorphous alumina film (film surface surface roughness [Ra]) was formed the passage of sample No.1-8. In addition, what does not form the DLC film as an example of a comparison is shown in a table 2 as sample No.9-12.

[0032]

[A table 1]

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試料 No	DLC膜の 厚み (μm)	アモルファスシリコン 膜の厚み (μm)	表面粗度Ra (\AA)		加熱処理 後膜剥離	抵抗値 Ω
			DLC膜	アモルファス シリコン膜		
※ 1	5	0.5	140	2.8	有	10^{13}
※ 2	4	0.5	108	2.6	有	10^{13}
3	3	0.5	78	2.5	無	10^{13}
4	2	0.5	51	3.1	無	10^{13}
5	1	0.5	28	2.7	無	10^{12}
※ 6	0.5	0.5	25	2.6	無	10^{10}
7	1	1	29	3.3	無	10^{12}
※ 8	1	1.5	28	3.0	有	10^{13}

※印の試料Noは本発明の範囲外のものである。

[0033]

[0034]

[A table 2]

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試料 No	アモルファスアルミナ 膜の厚み (μm)	表面粗度 R a (\AA)	加熱処理 後膜剝離	抵抗値 Ω
9	4	3. 1	無	10^{11}
10	3	2. 9	無	10^9
11	2	3. 4	無	10^7
12	1	2. 7	無	10^6

[0035] When the surface roughness and the resistance of the film exfoliation after heat-treatment, the DLC film, and the amorphous alumina film were measured to each [these] sample, the result as shown in this table was obtained.

[0036] About the film exfoliation after heat-treatment, each sample was heated at the temperature of 600 degrees C within the vacuum ambient atmosphere, and the desquamative state of a membrane formation phase was checked with the differential interference microscope (50 times). Moreover, the surface roughness on the front face of the outermost was measured in AFM.

[0037] About ordinary temperature resistance, 20 place / phi 4 microinches of electrodes of Ti/Au were formed in the film surface, it had in ordinary temperature applied-voltage 10V, the resistance between a film front face and the rear face of a substrate was measured using the 3 terminal method, and the minimum resistance was calculated.

[0038] a passage clear from the result shown in a table 1 -- sample No.3- of this invention -- about 5 and 7, resistance was set to 1012ohms or more, the outstanding withstand voltage was obtained, film exfoliation stops having arisen after heat-treatment further, and surface roughness Ra became 3.3A or less.

[0039] Moreover, heat dissipation nature almost comparable as sample No.9 (what formed only the amorphous alumina film by the thickness of 4

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micrometers) in ** put in practical use was obtained, and when each sample of this invention produced the various thin film magnetic heads which formed the magnetic film in each sample of this invention and investigated the thermal asperity phenomenon, respectively, the generating decreased remarkably and it was convenient [a sample] in any way practically there.

[0040] however, sample No. -- since the DLC film was thick at 1 and 2, the surface roughness became large, therefore film exfoliation occurred between amorphous alumina film. Moreover, in sample No.6, since the DLC film was thin, resistance became small. Since the amorphous alumina film was still thicker at sample No.8, film exfoliation occurred.

[0041]

[Effect of the Invention] While being having carried out the laminating of the DLC film with a thickness of 0.7-3.5 micrometers and the amorphous alumina film with a thickness of 1.3 micrometers or less one by one and raising the heat dissipation nature of the thin film magnetic-head component section on the substrate in this invention as above, the contact to the media side of a component was prevented and the substrate for the thin film magnetic heads which was further excellent in film adhesion reinforcement, electric pressure-proofing, and field grace has been offered.

[0042] Moreover, in this invention, it is having used the substrate for the thin film magnetic heads of this invention, and the thin film magnetic head of high quality and high-reliability has been offered.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] (a) And (b) is the perspective view showing the substrate for the thin film magnetic heads of this invention.

[Drawing 2] It is an important section expanded sectional view by cutting plane line X-X in drawing 1 (a).

[Drawing 3] It is the important section expanded sectional view showing the layer system of the thin film magnetic head of this invention.

[Drawing 4] It is the explanatory view showing the busy condition of the thin film magnetic head of this invention.

[Description of Notations]

1 Substrate for Thin Film Magnetic Heads

2 Thin Film Magnetic Head

3 Slider

4 MR Component

5 Media

6 Substrate

7 DLC Film

8 Amorphous Alumina Film

9 Magnetic Film

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DRAWINGS

[Drawing 1]

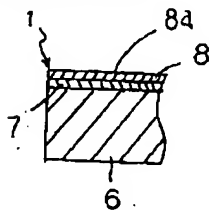
(a)



(b)

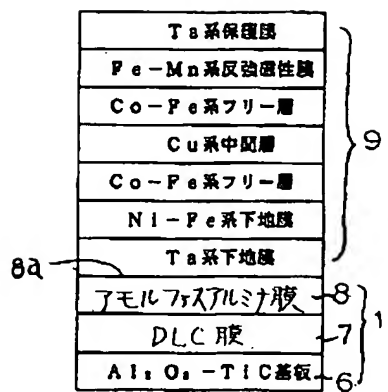


[Drawing 2]

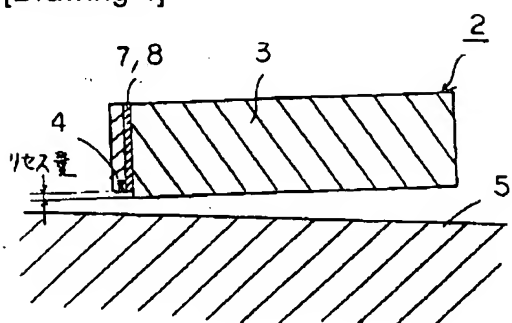


[Drawing 3]

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[Drawing 4]



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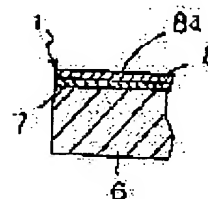
(72)Inventor : MATSUDA OSAMU

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(57)Abstract:

PROBLEM TO BE SOLVED: To improve heat radiating property of a thin-film magnetic head element and to prevent the contact of the element to a medium by successively depositing a diamond-like carbon film and amorphous alumina film to a specified thickness on a substrate.

SOLUTION: A diamond-like carbon film having 0.7 to 3.5 μm thickness and an amorphous alumina film having $\leq 1.3 \mu\text{m}$ thickness are deposited successively on a substrate. First, a diamond-like carbon(DLC) film 7 is formed through normal temperature plasma CVD method on a disk substrate 6 having an orientation flat face. Then an amorphous alumina film 8 is formed through RF sputtering or ECR sputtering. The amorphous alumina film 8 formed by RF sputtering or ECR sputtering has high film packing rate. Thereby, thermal conductivity is improved by the DLC film 7, and as a result, heat can be fast transferred to a slider having high conductivity and the heat radiating property is enhanced.



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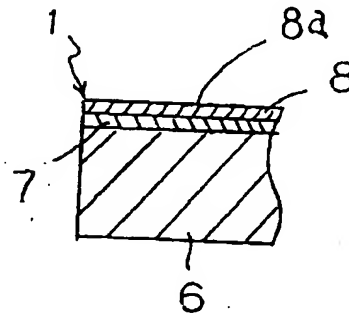
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(54)【発明の名称】 薄膜磁気ヘッド用基板およびこれを用いた薄膜磁気ヘッド

(57)【要約】

【課題】 薄膜磁気ヘッド素子部の放熱性を上げるとともに、素子のメディア面への接触を防止し、さらに膜密着強度、電気的な耐圧、面品位に優れた薄膜磁気ヘッド用基板を提供する。

【解決手段】 基板6上に厚み0.7～3.5 μ mのDL C膜7と、厚み1.3 μ m以下のアモルファスアルミナ膜8とを順次積層してなる薄膜磁気ヘッド用基板1。



【特許請求の範囲】

【請求項1】基板上に厚み0.7～3.5 μ mのダイヤモンド・ライク・カーボン膜と厚み1.3 μ m以下のアモルファスアルミナ膜とを順次積層してなる薄膜磁気ヘッド用基板。

【請求項2】請求項1の薄膜磁気ヘッド用基板のアモルファスアルミナ膜上に磁性膜を形成してなる薄膜磁気ヘッド。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はコンピュータの記録装置であるハードディスクドライブやテープドライブ等に用いられる薄膜磁気ヘッドならびにそれに用いる薄膜磁気ヘッド用基板に関するものである。

【0002】

【従来の技術】従来、薄膜磁気ヘッド用基板には主成分としてアルミナ(Al_2O_3)およびチタンカーバイド(TiC)の複合材からなるセラミック基板にアモルファスアルミナからなる絶縁膜をスパッタリング法にて成膜し、その面を片面ポリッシュ機にて鏡面加工したものが用いられている。

【0003】上記絶縁膜は導電材であるセラミック基板との絶縁性を得るため、さらに平滑性を達成するために形成するが、とくに絶縁膜の面粗さについては、その上に素子を形成するために重要であって、より平滑な面を得るためにCMP(CHEMICAL MECHANICAL POLISHING)等で加工している。

【0004】

【発明が解決しようとする問題点】近年、記録密度を向上させるために、薄膜磁気ヘッドの素子に磁気抵抗効果を用いたMR(MAGNETORESISTIVE)、あるいはGMR(Giant MR)が用いることが提示されているが、このようなMR素子やGMR素子の場合、読み取り感度を向上させるためにセンス電流値を上げる必要がある。

【0005】また、ハードディスクドライブ用MRヘッドやGMRヘッドにおいては、ヘッドの浮上量が1マイクロインチ程度と小さく、ニアコンタクトに近くなっている。そのため磁気ヘッドとメディアが接触摺動しやすく、この時の摩擦熱により薄膜磁気ヘッドのMR素子部に温度変化が生じ、その結果、読み取り感度が低減する、いわゆるサーマルアスペリティ現象が非常に大きな問題点となってきた。

【0006】かかる問題点を解消するために、素子周りの放熱性を上げる必要があるが、そのためにアモルファスアルミナ膜の厚みを薄くして、MR素子を熱伝導の高い Al_2O_3 -TiC基板に近づけ、これによって放熱性を上げたり、もしくは Al_2O_3 -TiC基板とアモルファスアルミナ膜との硬度差によるリセスを利用し、MR素子がメディア面と衝突することを防止する等の対

策がおこなわれている。

【0007】しかしながら、アモルファスアルミナ膜の膜厚が3 μ m以下になると、耐電圧の点で不十分であった。

【0008】したがって本発明者は上記事情に鑑みて鋭意研究を重ねた結果、アモルファスアルミナ膜に比べ熱伝導性および耐電圧特性の双方ともに優れたダイヤモンド・ライク・カーボン膜を被覆させることで、かかる問題点が解消されることを見出した。

10 【0009】本発明は上記知見に基づいて完成されたものであり、その目的は薄膜磁気ヘッド素子部の放熱性を上げるとともに、素子のメディア面への接触を防止し、さらに膜密着強度、電気的な耐圧、面品位に優れた薄膜磁気ヘッド用基板を提供することにある。

【0010】本発明の他の目的は本発明の薄膜磁気ヘッド用基板を用いた高品質かつ高信頼性の薄膜磁気ヘッドを提供することにある。

【0011】

20 【問題点を解決するための手段】本発明の薄膜磁気ヘッド用基板は、基板上に厚み0.7～3.5 μ mのダイヤモンド・ライク・カーボン膜と厚み1.3 μ m以下のアモルファスアルミナ膜とを順次積層したことを特徴とする。

【0012】本発明の薄膜磁気ヘッドは、本発明の薄膜磁気ヘッド用基板のアモルファスアルミナ膜上に磁性膜を形成してなることを特徴とする。

【0013】

【発明の実施の形態】以下、本発明の実施形態を図1～図4によって説明する。図1の(a)および(b)は本発明の薄膜磁気ヘッド用基板1を示す斜視図、図2は図1(a)における切断面線X-Xによる要部拡大断面図、図3は本発明の薄膜磁気ヘッド用基板1の上に磁性膜を形成した層構造を示す要部拡大断面図である。また、図4は本発明の薄膜磁気ヘッド2の使用状態を示す断面図である。

【0014】図4の薄膜磁気ヘッド2において、3は Al_2O_3 -TiC系セラミックス、フェライト、サファイアなどからなるスライダ、4はMR素子、5はメディアである。

40 【0015】上記薄膜磁気ヘッド2は下記の製造工程により得られる。まず、図1の薄膜磁気ヘッド用基板1によれば、(a)に示すようにオリエンテーションフラットを有する直径2～8インチの円板状基板6、もしくは(b)に示すように一辺3～6インチの角板状基板6である。これらの基板6の上に、図2に示すようにダイヤモンド・ライク・カーボン(DLC)膜7を常温プラズマCVD法により形成し、ついでアモルファスアルミナ膜8をRFスパッタ法やECRスパッタ法により形成する。ちなみに上記常温プラズマCVD法については高真空中の放電プラズマ中で炭化水素ガスを分解し、プラズ

マ中のイオン、励起分子を基板に電氣的に加速し、このような高エネルギーでもって衝突させることで形成する。

【0016】上記DLC膜7は炭素原子4個の結合形体においてダイヤモンドがほとんどSP₃軌道であるのに対しSP₃軌道とSP₂軌道の両方を含むものであって、表面平滑性に優れ、さらに硬度が高く、耐摩耗性に優れている。

【0017】また、DLC膜7はアモルファスアルミナ膜8に比べ熱伝導性が高く、さらに電氣的絶縁性にも優れるが、その反面、表面性状に劣り、膜欠陥が生じやすい。さらにDLC膜7はHV3000以上の高硬度なために、表面研磨がむずかしく、表面平滑化が困難である。

【0018】そこで、DLC膜7の欠点を補完させるために、その上にアモルファスアルミナ膜8を形成し、これによって表面を平滑にするとともに、欠陥の発生を防止し、良好で高い耐電圧を具備させる。

【0019】アモルファスアルミナ膜8を形成したことで、その表面8aはきわめて滑らかな面となり、ついで図3に示すように表面8aの上に磁性膜9を形成する。このようなウエハ工程の後に、スライシング工程、ABS面ポリッシュ工程、イオンミリング加工(RIE加工)を順次経て、多数の薄膜磁気ヘッド2を同時に得る。MR素子については、読み込みで使用する素子であって、フォトリソグラフによる微細加工技術で形成する。

【0020】上記基板6をAl₂O₃-TiC系セラミックスで作製する場合には、60~80%のAl₂O₃と40~20%のTiCを主成分とする原料を用い、大気あるいは還元雰囲気中1600~1800℃でホットプレスあるいはHIP処理して得られる。このAl₂O₃-TiC系セラミックスは非常に緻密な焼結体となり、表面を滑らかにすることができる。なお、Al₂O₃-TiC系セラミックスは導電材であるが、基板6上にDLC膜7とアモルファスアルミナ膜8を形成することによって絶縁性をもたせる。

【0021】また、アモルファスアルミナ膜8を形成した後は、膜表面をさらに平滑にすべくCMP加工するよい。

【0022】これによって、表面はAFM(ATOMIC FORCE MICROSCOPY)で測定される表面粗度(Ra)であらわすと、10Å以下にできる。

【0023】そして、かかる研磨後の厚みを1.3μm以下、好適には1μm以下にするとよく、これによってアモルファスアルミナ膜8を通してDLC膜7に放熱される効率が高くなる点で望ましい。

【0024】また、DLC膜7の厚みを0.7~3.5μm、好適には1~3μmにするとよく、0.7μm未満の場合には耐電圧が低下し、3.5μmを越えるとア

モルファスアルミナ膜8との間で剥離する。

【0025】かくして常温プラズマCVD法により形成したDLC膜7では、膜内および膜表面に多くの欠陥が発生しているが、さらにRFスパッタ法やECRスパッタ法により形成したアモルファスアルミナ膜8では高い成膜充填率が得られ、これにより、DLC膜7でもって熱伝導性を高め、その結果、熱伝導性の高いスライダ3に熱をよりはやく伝えることができ、放熱性が高められた。

10 【0026】また、DLC膜7によって耐電圧特性も高め(DLC膜7とアモルファスアルミナ膜8との積層に対する印加電圧10Vにおける常温抵抗値は10¹¹Ω以上となる)、しかも、アモルファスアルミナ膜8でもって優れた表面平滑性が得られたことで、面品位に優れた薄膜磁気ヘッド用基板1が提供された。

【0027】

【実施例】以下、本発明の実施例を説明する。出発原料としてアルミナ(純度99.9%、原料粉末の平均粒径:0.4μm)とチタンカーバイド(純度99.5%、原料粉末の平均粒径:0.3μm)を使用し、アルミナが70重量%、チタンカーバイドが30重量%の比率となるように秤量し、さらにチタンカーバイドに対し約10重量%の酸化チタンTiO₂を添加し、そして、アルミナボールにて混合した。ついで混合粉末を成形し、1600℃、250kg/cm²の圧力で1時間ホットプレス焼成した。

【0028】このようにして作製した焼結体をダイヤモンドホイールにより所定の円板形状に研削加工した後、ダイヤモンド砥粒を用いて表面のラッピング加工をおこなった。ついで平均粒径0.5μmのダイヤモンドパウダーを用いて、基板表面と研磨板あるいは研磨布を相対的に摺動させて精密研磨をおこない、これによって基板の表面粗度Raを18Åとした。本実施例では上記研磨板として錫定盤を用いた。

【0029】つぎに下記成膜工程にともなう成膜応力に起因して基板自体が変形することから、あらかじめ成膜裏面をショットブラスト処理をおこない、基板表面の平面度を凹面に変形しておく。

40 【0030】そして、表1に示すとおり、メタンガスと水素ガスを用いて、RFプラズマCVD法(RF電力:500W、DCバイアス:-250V)によりDLC膜を1~5μmの範囲で成膜形成した。このような膜の表面粗度Raは28~140Åである。

【0031】さらに純度99.5%のアルミナターゲットを用いてスパッタ法にて、アモルファスアルミナ膜を3μmの厚みで成膜し、その後、球状アルミナ微粉末を純水中に懸濁させた研磨液にて鏡面加工をおこなった後、球状セリア微粉末を純水中に懸濁させた研磨液にて最終精密加工をおこない、試料No.1~8のとおり、厚みを変えたDLC膜と、0.5μm、1μm、1.5

μm の厚みのアモルファスアルミナ膜（膜面表面粗度 R_a ）との積層を形成した。なお、比較例としてDLC膜を形成しないものを表2に試料No. 9～12と*

*して示す。

【0032】

【表1】

試料 No	DLC膜の 厚み (μm)	アモルファス アルミナ 膜の厚み (μm)	表面粗度 R_a (\AA)		加熱処理 後膜剥離	抵抗値 Ω
			DLC膜	アモルファス アルミナ膜		
※ 1	5	0.5	140	2.8	有	10^{13}
※ 2	4	0.5	108	2.6	有	10^{13}
3	3	0.5	78	2.5	無	10^{13}
4	2	0.5	51	3.1	無	10^{13}
5	1	0.5	28	2.7	無	10^{12}
※ 6	0.5	0.5	25	2.6	無	10^{10}
7	1	1	29	3.3	無	10^{12}
※ 8	1	1.5	28	3.0	有	10^{11}

※印の試料Noは本発明の範囲外のものである。

【0033】

※【表2】

【0034】

※

試料 No	アモルファスアルミナ 膜の厚み (μm)	表面粗度 R_a (\AA)	加熱処理 後膜剥離	抵抗値 Ω
9	4	3.1	無	10^{11}
10	3	2.9	無	10^9
11	2	3.4	無	10^7
12	1	2.7	無	10^5

【0035】 これら各試料に対し、加熱処理後の膜剥離、DLC膜とアモルファスアルミナ膜の表面粗度および抵抗値を測定したところ、同表に示すような結果が得られた。

【0036】加熱処理後の膜剥離については、各試料を真空雰囲気内で600℃の温度で加熱し、微分干渉顕微鏡（50倍）にて成膜段階の剥離状態を確認した。また、最外表面の表面粗度はAFMにて測定した。

【0037】常温抵抗値についてはTi/Auの電極を膜面に20ヶ所/φ4マイクロインチ形成し、常温で印加電圧10Vでもって三端子法を用いて膜表面と、基板の裏面との間の抵抗値を測定し、最低抵抗値を求めた。

【0038】表1に示す結果から明らかとなり、本発明の試料No. 3～5、7については、抵抗値は $10^{12} \Omega$ 以上になり、優れた耐電圧が得られ、さらに加熱処理後に膜剥離が生じなくなり、表面粗度Raは3.3Å以下になった。

【0039】また、本発明の各試料はすでの実用化されている試料No. 9（アモルファスアルミナ膜だけを4μmの厚みで形成したもの）とほぼ同程度の放熱性が得られており、そこで、本発明の各試料に磁性膜を形成した各種薄膜磁気ヘッドを作製し、それぞれサーマルアスペリティ現象を調べたところ、その発生が著しく減少し、実用上何ら支障がなかった。

【0040】しかるに試料No. 1、2ではDLC膜が厚いので、その表面粗さが大きくなり、そのためにアモルファスアルミナ膜との間で膜剥離が発生した。また、試料No. 6においては、DLC膜が薄いので、抵抗値が小さくなった。さらに試料No. 8ではアモルファスアルミナ膜が厚いので、膜剥離が発生した。

【0041】

【発明の効果】以上のとおり、本発明においては、基板

上に厚み0.7～3.5μmのDLC膜と厚み1.3μm以下のアモルファスアルミナ膜とを順次積層したことで、薄膜磁気ヘッド素子部の放熱性を上げるとともに、素子のメディア面への接触を防止し、さらに膜密着強度、電気的な耐圧、面品位に優れた薄膜磁気ヘッド用基板が提供できた。

【0042】また、本発明においては、本発明の薄膜磁気ヘッド用基板を用いたことで、高品質かつ高信頼性の薄膜磁気ヘッドが提供できた。

10 【図面の簡単な説明】

【図1】（a）および（b）は本発明の薄膜磁気ヘッド用基板を示す斜視図である。

【図2】図1（a）における切断面線X-Xによる要部拡大断面図である。

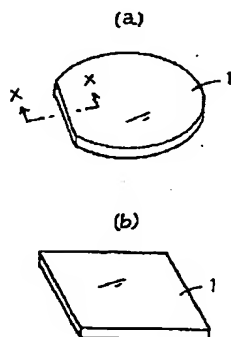
【図3】本発明の薄膜磁気ヘッドの層構造を示す要部拡大断面図である。

【図4】本発明の薄膜磁気ヘッドの使用状態を示す説明図である。

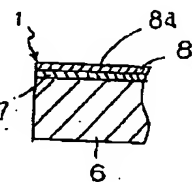
【符号の説明】

- | | | |
|----|---|-------------|
| 20 | 1 | 薄膜磁気ヘッド用基板 |
| | 2 | 薄膜磁気ヘッド |
| | 3 | スライダ |
| | 4 | MR素子 |
| | 5 | メディア |
| | 6 | 基板 |
| | 7 | DLC膜 |
| | 8 | アモルファスアルミナ膜 |
| | 9 | 磁性膜 |

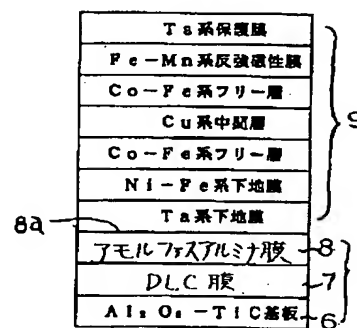
【図1】



【図2】



【図3】



【図 4】

